(12) UK Patent Application (19) GB (11) 2 295 679 (13) A

(43) Date of A Publication 05.06.1996

(21) Application No 9524122.0

(22) Date of Filing 24.11.1995

(30) Priority Data
(31) P4443142 (32) 03.12.1994 (33) DE

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(51) INT CL[6]
G01N 33/497

(52) UK CL (Edition O)
G1N NBMX N25A1 N25DX N25E1
U1S S1515

(56) Documents Cited
GB 2285136 A GB 2016148 A EP 0172969 A2
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(58) Field of Search
UK CL (Edition O) G1A ADJA, G1N NACJ NBMA NBMX NCGB
INT CL[6] G01N 33/497
ONLINE: WPI

(54) Determination of alcohol in exhaled air

(57) The concentration of alcohol in exhaled breath is determined by delivering a first gas sample into the measuring cell at a first time t = t1, at the beginning of the exhalation and recording a first measuring curve 14, delivering a second gas sample into the measuring cell at a second time t = t3, during the same exhalation, at which the breath from the mouth has been eliminated, and determining a second measuring curve 15, determining a predetermined first parameter i_{1m} from the first measuring curve 14 and a predetermined second parameter i_{2m} from the second measuring curve 15, and comparing the parameters i_{1m} and i_{2m} of an exhalation with one another. The measurements may be made in the same or different sensors which may be electrochemical. The measurements may be the maximum values of the curves, or integrals of the curves, and alcohol is determined to be present if the first parameter is greater than the second parameter.

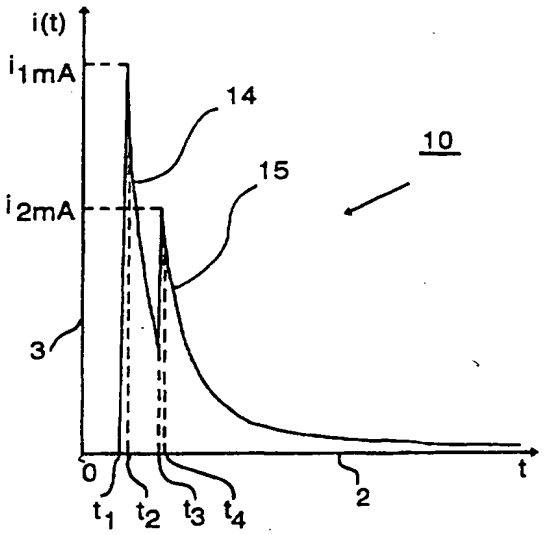

Fig.2

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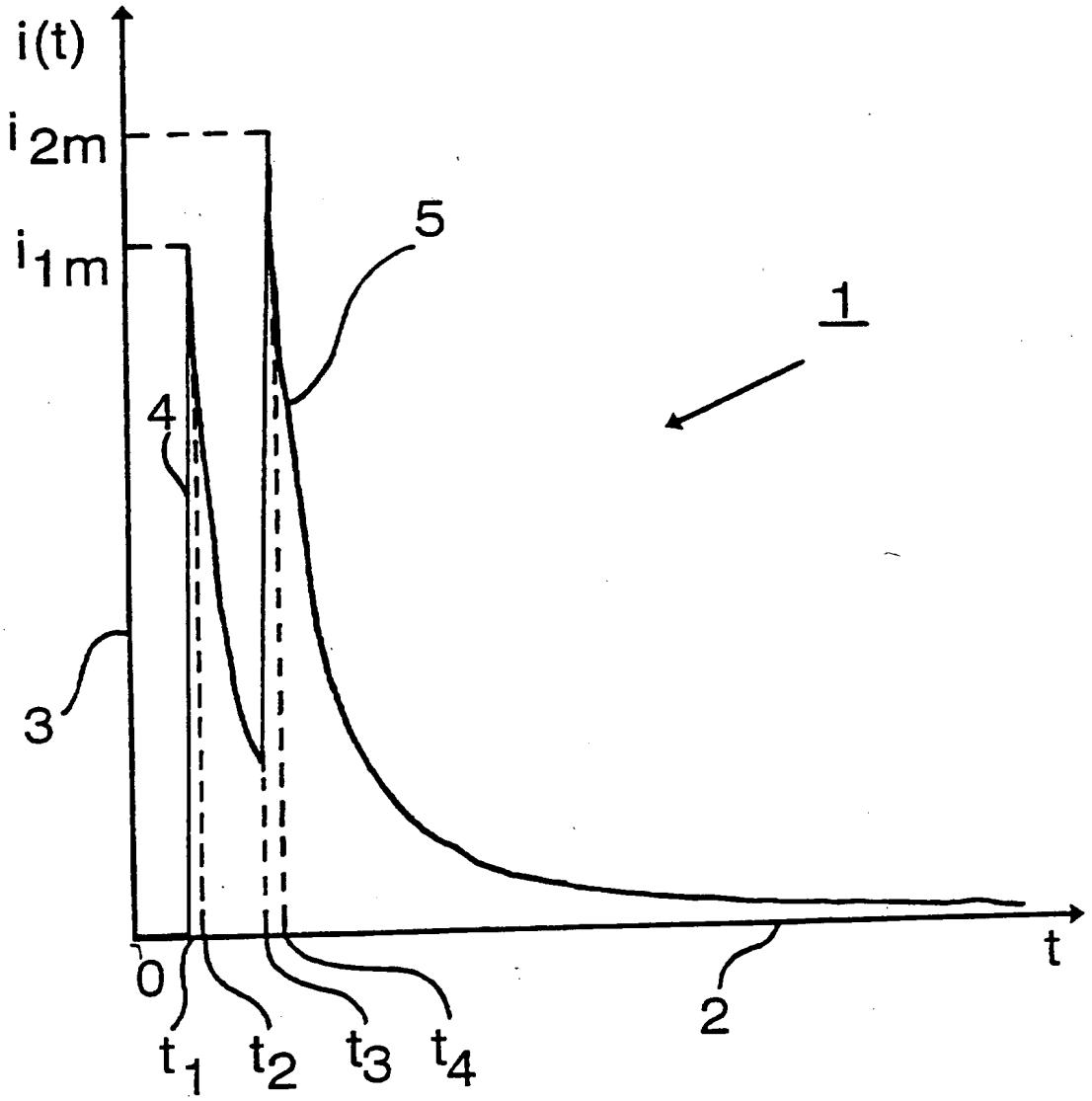

Fig.1

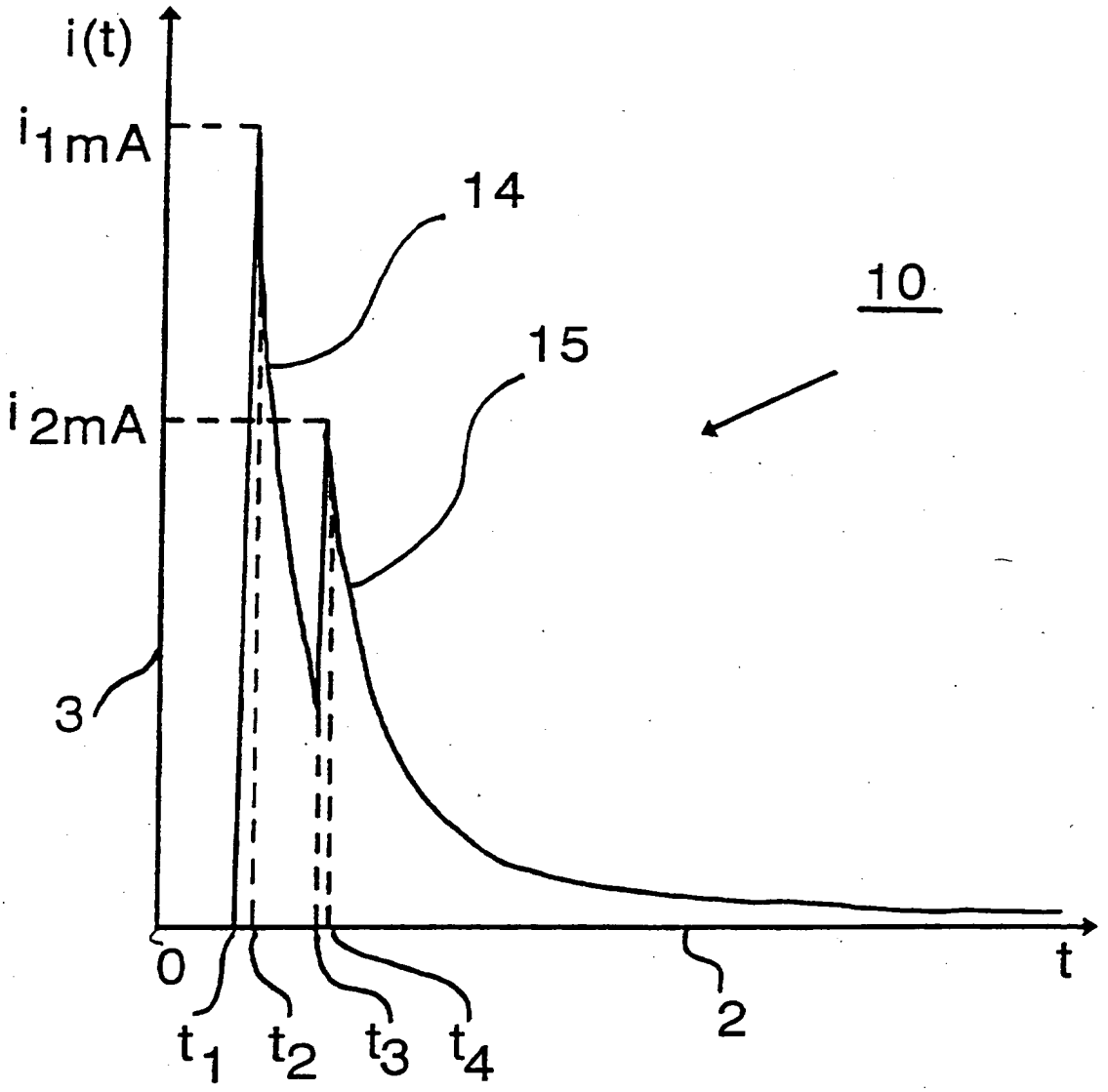

Fig.2

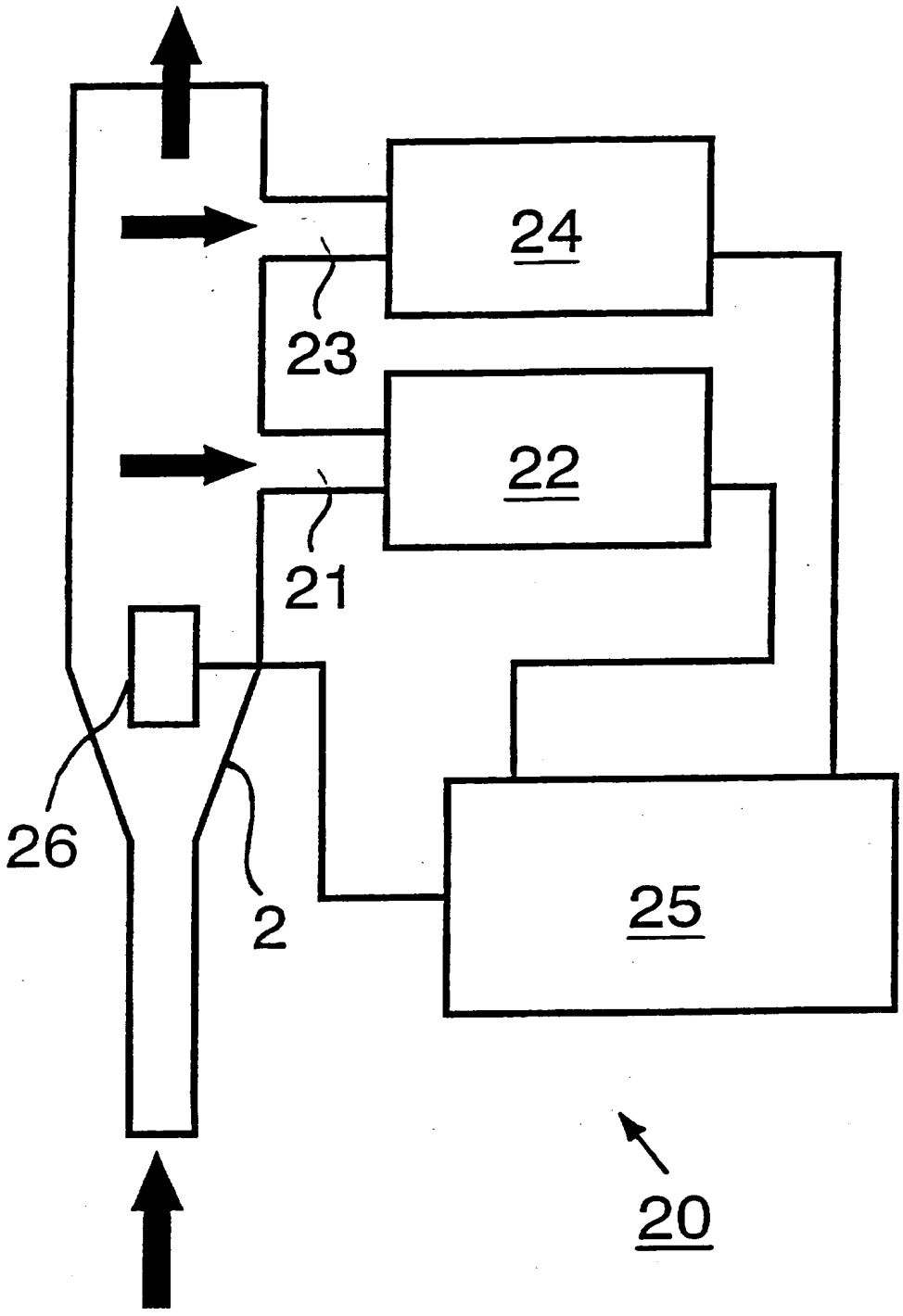

Fig.3

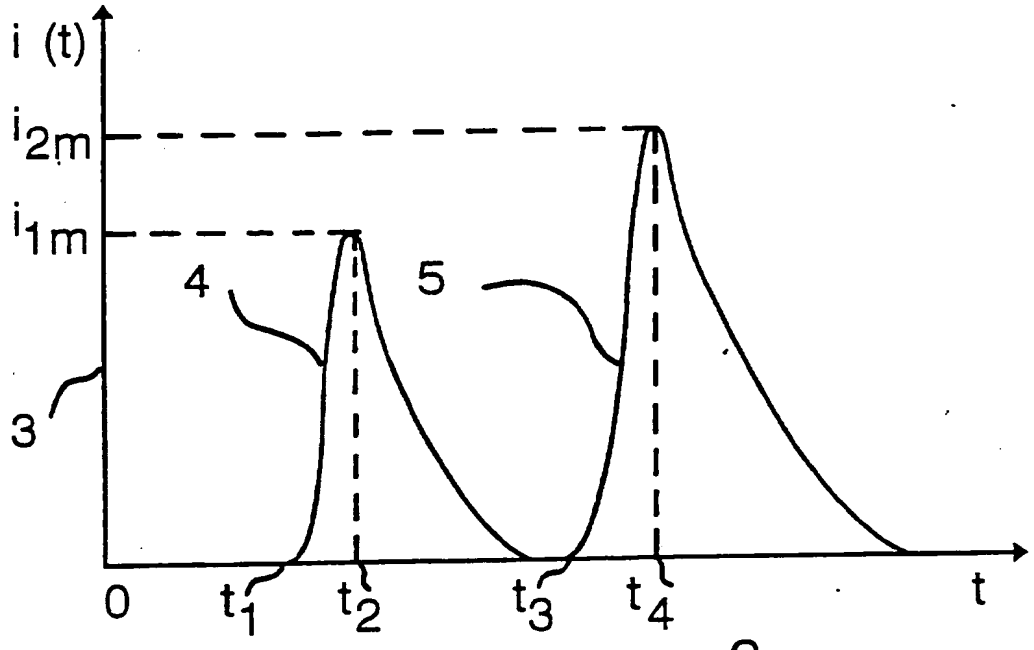

Fig.4

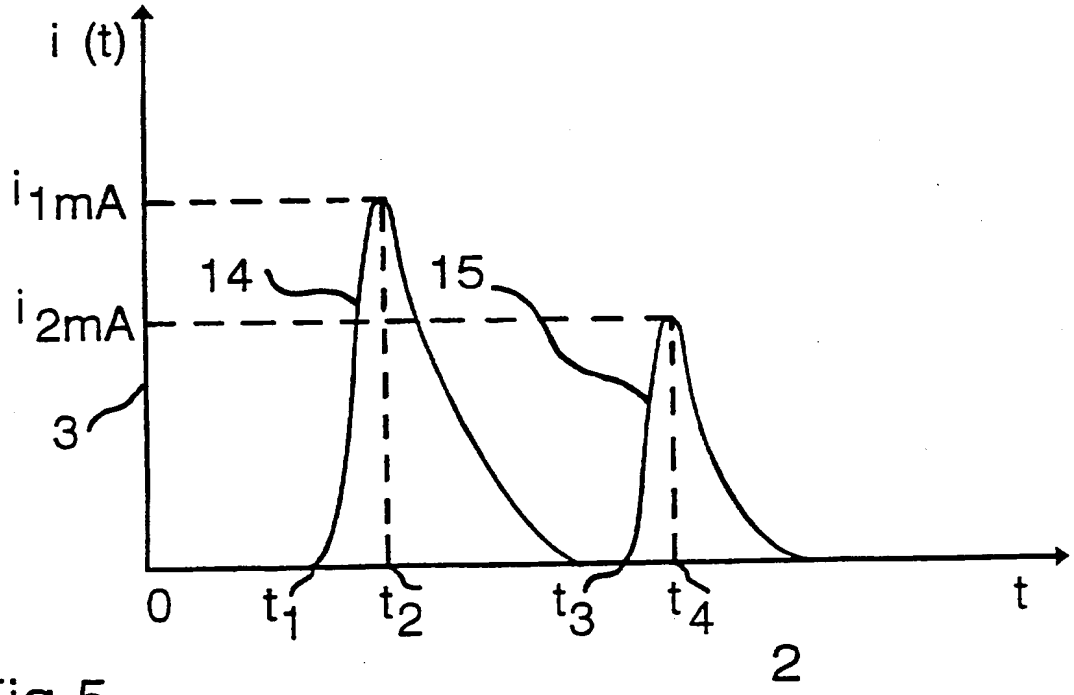

Fig.5

METHOD AND APPARATUS FOR THE DETERMINATION OF THE CONCENTRATION OF ALCOHOL IN EXHALED AIR

The invention relates to a method for the determination of the concentration of alcohol in exhaled air, in which during an exhalation a gas sample is passed into a measuring chamber of a detecting device and a measuring curve proportional to the alcohol concentration is produced, and to an apparatus therefor.

DE 39 04 994 A1 discloses an apparatus for conveying a gaseous sample into the measuring chamber of a detecting device in order to determine the proportion of alcohol in the gas sample. With the aid of a piston-cylinder unit the gas sample is pumped out of the exhaled air into the measuring chamber of the detecting apparatus. The detecting apparatus consists of an electrochemical measuring cell which includes a membrane permeable to alcohol molecules. During the sampling stroke the gas sample is guided along an indirect path over a large part of the membrane surface, so that a rapid reaction of the alcohol molecules in the electrochemical measuring cell is achieved. By means of the indirect path a short response time of the measuring cell is obtained, since the largest part of the sample of gas being measured is already evaluated during the short suction stroke. After the reaction of the alcohol molecules the piston performs an exhaust stroke in order to remove the evaluated sample gas from the measuring chamber again.

This known apparatus performs the sampling stroke at a time at which any portions of the breath alcohol coming from the oral cavity have been breathed out, since these could falsify the result of measurement in the direction of a too high indication. But even if the sampling is undertaken at a later time during the exhalation, if oral alcohol is present there is no

assurance that only the portion of the alcohol in the alveolar air is measured.

When using other principles of measurement for the determination of the alcohol concentration, e.g. those which operate according to the infra-red absorption principle, it is possible to measure the alcohol concentration with sufficient accuracy practically without delay, so that the presence of oral alcohol can be recognised from the shape of the concentration curve. However, such measuring methods require a higher outlay on apparatus. An apparatus operating according to the infrared absorption principle is shown in DE 26 10 578 B2.

The invention, therefore, seeks to provide, for a detecting device which, because of its time constant, does not enable a direct determination of the variation in concentration to be made, a method of recognising the presence of oral alcohol in the breath sample.

According to a first aspect of the present invention, there is provided an apparatus for determining the concentration of alcohol in exhaled breath, comprising:

a detection means having a measuring chamber into which a gas sample is passed during exhalation;

measurement means for measuring a first measuring curve of a first gas sample at the beginning of an exhalation, and a second measuring curve of a second gas sample during the same exhalation at a later time when the breath from the mouth has been eliminated;

means for determining a first parameter from the first measuring curve, and a second parameter from the second measuring curve; and

comparison means for comparing the first and second parameters of an exhalation with one another.

According to a second aspect of the present invention, there is provided a method for the

determination of the concentration of alcohol in exhaled breath, wherein during an exhalation a gas sample is passed into a measuring chamber of a detector device and a measuring curve proportional to the alcohol concentration is produced, the method comprising the steps of:

recording a first measuring curve of a first gas sample, at the beginning of an exhalation;

determining a second measuring curve of a second gas sample during the same exhalation, at a later time when the breath from the mouth has been eliminated; and

determining a first parameter from the first measuring curve and a second parameter from the second measuring curve, and comparing the first and second parameters of an exhalation with one another.

The advantage of the invention consists essentially in that during an exhalation two samples of gas to be measured are analysed, namely a first sample at the beginning of the exhalation, when the gas breathed out comes predominantly from the oral cavity, and a second sample at a later point in time when the breath from the mouth has largely been eliminated. The two samples can either be evaluated one after the other through a double sampling stroke with one detecting device, or by the use of two detecting devices. The measuring curves obtained from the two samples are compared with one another, and from the measuring curves parameters characteristic of the shape of the measuring curves are determined which are used for the detection of the oral alcohol. With the method according to the invention it is possible to indicate the presence of oral alcohol in the case of those detecting devices which do not allow a direct determination of concentration, e.g. slow IR sensors or semiconductor sensors. Electrochemical sensors can be used with particular advantage.

Advantageously the parameters used for the evaluation of the measuring curves are the maximum values of the measuring curves, a first maximum value being associated with the first measuring curve and a second maximum value being associated with the second measuring curve. Instead of the maximum values, integral values under the measuring curves can be formed as parameters and used as parameters for the evaluation.

Advantageously the first gas sample is delivered at a time shortly after the beginning of the exhalation, i.e. within a second after the beginning of the exhalation, and the time of taking the second gas sample is selected so that at which about 50% of the volume of the exhalation has been breathed out.

Advantageously the first maximum value is compared with the second maximum value in one inhalation and the presence of oral alcohol is indicated in the event that the first maximum value is greater than the second maximum value. In the event that integral values are formed, these are compared with one another.

By way of example, an embodiment of the invention is illustrated in the drawings and is described in more detail below. In the drawings:

Figure 1 shows a measuring curve of a breath sample without oral alcohol,

Figure 2 shows a measuring curve of a breath sample with oral alcohol,

Figure 3 shows an apparatus in accordance with the invention with two measuring cells,

Figure 4 shows a measuring curve of a breath sample without oral alcohol for the apparatus shown in Figure 3 and

Figure 5 shows a measuring curve of a breath sample with oral alcohol for the apparatus shown in Figure 3.

Figure 1 shows a measuring curve (1) of an electrochemical measuring cell (not shown in the Figure) which is exposed to two gas samples in succession. The measuring cell may, for example, be constructed in accordance with DE 39 04 994 A1. The time t is plotted on the abscissa (2) of the coordinate system shown in Figure 1, and the sensor current i(t) is plotted on the ordinate (3). For simplicity, let it be assumed that the exhalation begins at the time t = 0 and the reference line for the sensor current i(t) coincides with the abscissa (2). Shortly after the beginning of the exhalation, at the time $t = t_1$, a first gas sample is delivered and supplied to the electrochemical measuring cell. The electrochemical reaction of the alcohol molecules results in a first measuring curve (4) with a first maximum value i_{1m} which is reached at the time $t = t_2$. At a time $t = t_3$, when at least 50% of the exhalation has been breathed out, a second gas sample is delivered into the measuring cell, and a second measuring curve (5) is obtained with a second maximum value i_{2m} at the time $t = t_4$. After passing the second maximum value i_{2m} the second measuring curve (5) falls steeply and then approaches the abscissa (2) asymptotically. In the present case the exhaled air contains no oral alcohol, and the first maximum value i_{1m} is smaller than the second maximum value i_{2m}. The different magnitudes of the maximum values i_{1m} and i_{2m} is due to the fact that at the time $t = t_3$, when the second gas sample is delivered, the alcohol molecules of the first gas sample have still not reacted completely.

Figure 2 show a measuring curve (10) of an exhalation which contains oral alcohol. At the time $t = t_1$ a first gas sample is delivered into the measuring cell, and then a first measuring curve (14) with a first maximum value i_{1mA} is again recorded, and at the

time $t = t_3$ a second gas sample arrives in the measuring cell, the electrochemical reaction of the alcohol molecules of the second gas sample leading to a second measuring curve (15) with a second maximum value i_{2mA}. The times t_1, t_2, t_3 and t_4 of the measuring curve (1) correspond to the times t_1, t_2, t_3 and t_4 of the measuring curve (10). The index "A" stands for the exhalation with oral alcohol. In the case of the first measuring curve (14) the first maximum value i_{1mA} is clearly greater than the second maximum value i_{2mA}, since at the time $t = t_1$ the gas sample essentially comprises the alcohol molecules present in the oral cavity, while at the time $t = t_3$ the alcohol concentration of the alveolar air portion predominates. The maximum values i_{1mA}, i_{2mA} are fed to a comparator (not shown in the Figure), and in the event that i_{1mA} is greater than i_{2mA} a display unit (likewise not shown in the Figures) is activated which indicates the presence of oral alcohol, so that the concentration measurement is rejected or only used with reservations.

Figure 3 shows an apparatus (20) with a sample collecting device (2) for delivery of a first gas sample through a first line (21) into a first electrochemical measuring cell (22) and for delivery of a second gas sample through a second line (23) into a second electrochemical measuring cell (24). The measuring cells (22, 24) are connected to an evaluation and control unit (25), which initiates the sampling and registers and evaluates the measuring signals delivered from the measuring cells (22, 24). Also connected to the control unit (25) is a flow sensor (26) which registers the beginning of an exhalation, i.e. the time $t = 0$ for the sampling.

Figure 4 shows measuring curves (4, 5) which were recorded with the apparatus (20) according to Figure 3 and belong to a breath sample without oral alcohol.

For simplicity it is again assumed that the exhalation takes place at the time t = 0. Shortly after the beginning of the exhalation, at the time $t = t_1$, a first gas sample is delivered through the first measuring cell (22), which contains a delivery device, and is evaluated as first measuring curve (4) in the control unit (25). At the time $t = t_3$, when at least 50% of the exhalation has been breathed out, a second gas sample is delivered through the second measuring cell (24) and evaluated as second measuring curve. Since there is no influence due to oral alcohol, the maximum values i_{1m}, i_{2m} of the two measuring curves (4, 5) ought to be the same. Since, however, at the start of the exhalation some of the alcohol molecules are absorbed by the oral mucous membranes, the maximum value i_{1m} is smaller than the maximum value i_{2m}. In Figure 4 this difference is exaggerated for clarity. The times t_1 to t_4 of Figures 4 and 5 correspond to the times t_1 to t_4 of Figures 1 and 2. The measuring curves (4, 5) of the measuring cells (22, 24) are shown in Figure 4 within a coordinate system. In the case of a breath sample with oral alcohol the curve shape shown in Figure 5 is obtained. At the time $t = t_1$ the first gas sample is delivered through the first measuring cell (22) and a first measuring curve (14) with a first maximum value i_{1mA} is obtained. The second gas sample delivered at the time $t = t_3$ into the second measuring cell (24) gives a second measuring curve (15) with a second maximum value i_{2mA}. A comparison of the maximum values i_{1mA} and i_{2mA} in the control unit (25) shows that i_{1mA} is greater than i_{2mA}, which is indicated as the presence of oral alcohol.

CLAIMS

1. An apparatus for determining the concentration of alcohol in exhaled breath, comprising:

a detection means having a measuring chamber into which a gas sample is passed during exhalation;

measurement means for measuring a first measuring curve of a first gas sample at the beginning of an exhalation, and a second measuring curve of a second gas sample during the same exhalation at a later time when the breath from the mouth has been eliminated;

means for determining a first parameter from the first measuring curve, and a second parameter from the second measuring curve; and

comparison means for comparing the first and second parameters of an exhalation with one another.

2. An apparatus for determining the concentration of alcohol in exhaled breath as claimed in claim 1, wherein the detection means comprises a first detector device having a first measurement chamber to which the first gas sample is delivered, and a second detector device having a second measurement chamber to which the second gas sample is delivered.

3. An apparatus for determining the concentration of alcohol in exhaled breath, as claimed in claim 1 or 2, wherein the first and second parameters are the maximum value of the first and second measuring curve, respectively.

4. An apparatus for determining the concentration of alcohol in exhaled breath, as claimed in claim 1 or 2, wherein the first and second parameters are integral values of the first and second measuring curve, respectively.

5. An apparatus for determining the concentration of alcohol in exhaled breath, as claimed in any preceding claim, wherein the comparison means determines that oral alcohol is present if the first

parameter is greater than the second parameter.

6. Apparatus for determining the concentration of alcohol in exhaled breath as claimed in one of claims 1 to 5, wherein the length of the response time of the detection means is such that it is less than one second.

7. Apparatus for determining the concentration of alcohol in exhaled breath as claimed in one of claims 1 to 6, wherein the or each measurement chamber comprises an electrochemical measuring cell and the measuring curves are formed by the electrochemical reaction of the alcohol molecules in the measuring cell.

8. A method for the determination of the concentration of alcohol in exhaled breath, wherein during an exhalation a gas sample is passed into a measuring chamber of a detector device and a measuring curve proportional to the alcohol concentration is produced, the method comprising the steps of:

recording a first measuring curve of a first gas sample, at the beginning of an exhalation;

determining a second measuring curve of a second gas sample during the same exhalation, at a later time when the breath from the mouth has been eliminated; and

determining a first parameter from the first measuring curve and a second parameter from the second measuring curve, and comparing the first and second parameters of an exhalation with one another.

9. A method as claimed in claim 8 wherein the first gas sample is delivered to the measuring chamber of a first detector device, and the second gas sample is delivered to the measuring chamber of a second detector device.

10. A method as claimed in claim 8, wherein the first and second gas samples are delivered at the first and second times, respectively to the measuring chamber

of a single detector device.

11. A method according to any of claims 8 to 10, wherein the first parameter is a maximum value of the first measuring curve and the second parameter is a maximum value of the second measuring curve.

12. A method according to any of claims 8 to 11, wherein the first parameter is an integral value of the first measuring curve and the second parameter is an integral value of the second measuring curve.

13. A method according to any of claims 8 to 12, wherein the second time is selected so that more than 50% of the volume of the exhalation has been breathed out.

14. A method as claimed in any of claims 8 to 13, wherein the first time $t = t_1$ lies in a time interval up to about one second after the beginning of the exhalation.

15. Method according to any of claims 8 to 14, wherein the first parameter is compared with the second parameter and in the event that the first parameter is greater than the second parameter it is indicated that oral alcohol is present.

16. A method substantially as herein described with reference to the accompanying drawings.

17. An apparatus substantially as herein described with reference to the accompanying drawings.

Amendments to the claims have been filed as follows

1. An apparatus for determining the concentration of alcohol in exhaled breath, comprising:

a detection means having a measuring chamber into which a gas sample is passed during exhalation;

measurement means adapted to measure a first measuring curve of a first gas sample at the beginning of an exhalation, and a second measuring curve of a second gas sample during the same exhalation at a later time when the breath from the mouth has been eliminated;

means for determining a first parameter from the first measuring curve, and a second parameter from the second measuring curve; and

comparison means for comparing the first and second parameters of an exhalation with one another.

2. An apparatus for determining the concentration of alcohol in exhaled breath as claimed in claim 1, wherein the detection means comprises a first detector device having a first measurement chamber to which the first gas sample is delivered, and a second detector device having a second measurement chamber to which the second gas sample is delivered.

3. An apparatus for determining the concentration of alcohol in exhaled breath, as claimed in claim 1 or 2, wherein the first and second parameters are the maximum value of the first and second measuring curve, respectively.

4. An apparatus for determining the concentration of alcohol in exhaled breath, as claimed in claim 1 or 2, wherein the first and second parameters are integral values of the first and second measuring curve, respectively.

5. An apparatus for determining the concentration of alcohol in exhaled breath, as claimed in any preceding claim, wherein the comparison means determines that oral alcohol is present if the first

parameter is greater than the second parameter.

6. Apparatus for determining the concentration of alcohol in exhaled breath as claimed in one of claims 1 to 5, wherein the length of the response time of the detection means is such that it is less than one second.

7. Apparatus for determining the concentration of alcohol in exhaled breath as claimed in one of claims 1 to 6, wherein the or each measurement chamber comprises an electrochemical measuring cell and the measuring curves are formed by the electrochemical reaction of the alcohol molecules in the measuring cell.

8. A method for the determination of the concentration of alcohol in exhaled breath, wherein during an exhalation a gas sample is passed into a measuring chamber of a detector device and a measuring curve proportional to the alcohol concentration is produced, the method comprising the steps of:

determining a first measuring curve of a first gas sample, at the beginning of an exhalation;

determining a second measuring curve of a second gas sample during the same exhalation, at a later time when the breath from the mouth has been eliminated; and

determining a first parameter from the first measuring curve and a second parameter from the second measuring curve, and comparing the first and second parameters of an exhalation with one another.

9. A method as claimed in claim 8 wherein the first gas sample is delivered to the measuring chamber of a first detector device, and the second gas sample is delivered to the measuring chamber of a second detector device.

10. A method as claimed in claim 8, wherein the first and second gas samples are delivered at the first and second times, respectively to the measuring chamber

The Patent Office

13

Application No: GB 9524122.0
Claims searched: 1-17

Examiner: David Mobbs
Date of search: 19 January 1996

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): G1A ADJA; G1N NACJ, NBMA, NBMX, NCGB.

Int Cl (Ed.6): G01N 33/497.

Other: ONLINE: WPI.

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 2,285,136 A	DRÄGERWERK AG	1, 4-5, 7-8, 10, 12-13, 15.
X	GB 2,016,148 A	DRÄGERWERK AG	1, 8, 10.
X	EP 0,172,969 A2	LION LABORATORIES LTD	1, 8.
X	US 5,048,321	INTOXIMETERS INC	1, 4-5, 7-8, 10, 12-13, 15.

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